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ABSTRACT

Questions often raised about intelligence tests are discussed: (1) the definition of intelligence; (2) the definition of intelligence quotient; (3) the kinds of tests available; (4) validity; (5) fairness to minority groups; (6) use made of test results; (7) differences in results among various intelligence tests; (8) differences in scores using the same test; (9) the effects of coaching; and (10) applicability of nonverbal tests. Guidelines are offered on the interpretation of intelligence tests as useful measures of general ability in school learning; use of tests to assess results of learning tasks conducted in school; interpretation of test results which take account of other factors (such as cumulative records, teacher observations, student motivation, or opportunity to learn those behaviors sampled by the test); the use of intelligence tests to predict general ability rather than success in a specific subject; and a higher correlation with subjects requiring thinking rather than with subjects mastered by rote learning. (MH)

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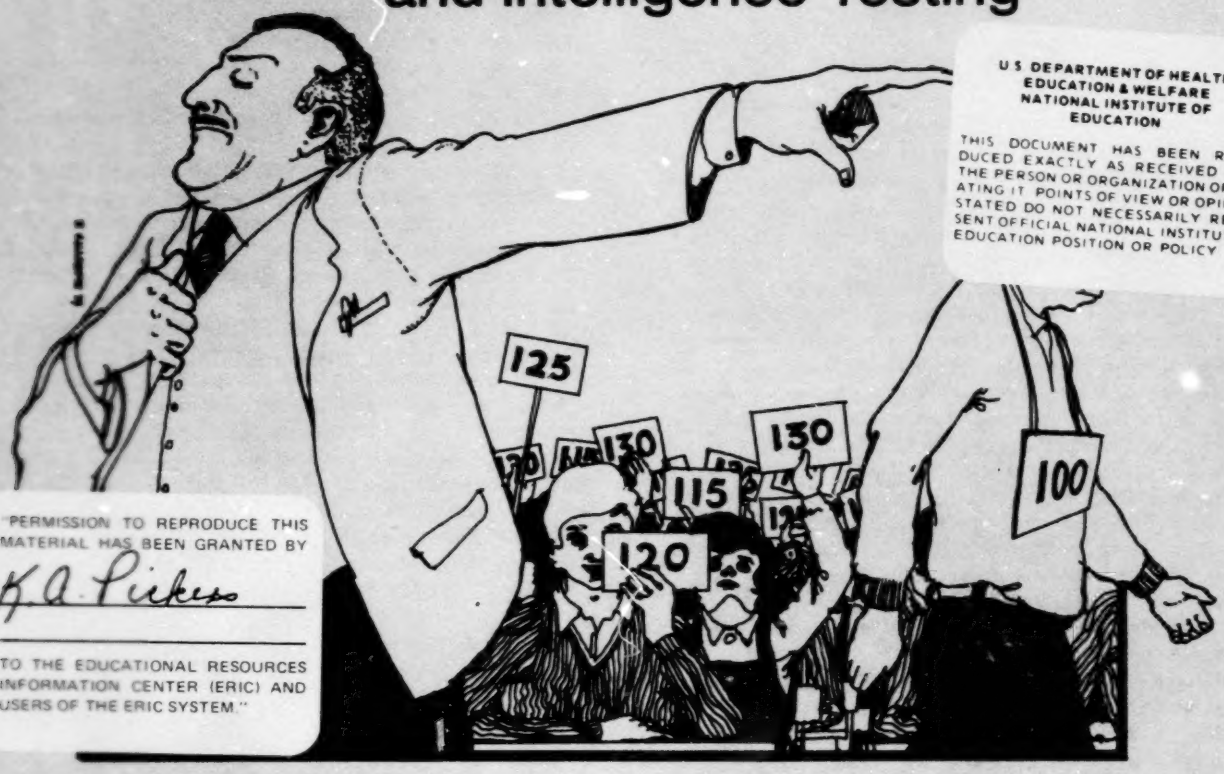
Intelligence and Intelligence Testing



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The true test of intelligence is the ability to ignore the results of an intelligence test. True or False?

Introduction

In this bulletin an attempt has been made to explain what is meant by the term intelligence, and to answer some of the queries concerning intelligence tests which teachers and principals often raise. More specifically, the purpose of the bulletin is to provide answers to the following questions:

- What is intelligence?
- What is an IQ?
- What kinds of intelligence tests are available in New Zealand?
- Are intelligence tests valid?
- Are they fair to minority groups?
- Why test at all? What use is made of the results?
- Why do results from different intelligence tests sometimes disagree?
- Should the same result always be obtained with the same test?
- Are intelligence tests susceptible to coaching?
- When should a non-verbal test be used?

What is intelligence?

Discussions about intelligence are often characterized by controversy and misunderstandings, partly because people use the term intelligence in different ways. Hebb, for example, distinguished two different meanings. The first defined intelligence as the innate capacity of the individual, that is, something the child inherits through his genes and which determines the mental growth of which he is capable. This form of intelligence, termed *Intelligence A*, is neither observable nor measurable.

A second meaning refers to what the individual does, to his observed behaviour. The child or adult who is clever, quick on the uptake, good at comprehending and reasoning, is usually considered to be intelligent. Hebb termed this *Intelligence B*. He pointed out that Intelligence A and B are not independent of each other. Intelligence A enters into and is a necessary component of Intelligence B which, although substantially influenced by an individual's physiological make-up, is to some degree dependent on the intensity of the intellectual stimulation which an individual receives in the early years. A person's Intelligence B is the outcome of the interaction between his Intelligence A and his environment.

Vernon accepted Hebb's meanings and added a third, *Intelligence C*, which is that aspect of Intelligence B measured by intelligence tests. The introduction of the concept Intelligence C seems desirable since scores on existing tests represent only a sample of all the cognitive abilities included in Intelligence B. Thus Intelligence C is the result not only of possible genetic and environmental factors but also of factors specific to the test and the test situation.

How far Intelligence C can serve as an index of Intelligence A or B is still a matter of disagreement among psychologists. In the 1920s many believed tests were measuring innate capacity, but the widely held view now is that tests of intelligence measure not innate intelligence but the abilities to solve problems, see relationships and carry on abstract thinking.

The most current and popular conception of intelligence stresses the importance of both innate and developmental influences. Intelligence is viewed as being a genetically

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determined basic ability modified by experience, and the ways in which people use their intelligence are determined by the unique learning history of the individual. The notions of Intelligence A, B, and C are useful in enabling us to be more specific in the way the term intelligence is used.

Is intelligence one ability or many abilities?

Notions about the structure of intelligence have changed appreciably since Spearman advanced, in 1927, the view that intelligence could be defined as a single general factor, *g*, and the common view now is that there are various types of abilities —verbal, numerical, spatial, perceptual, memorising, mechanical, creative and so on, and that the same individual may show strength in one and weakness in another, although the specific abilities do tend to correlate positively. One should note, however, that there are points of difference between theorists regarding the number of these ability factors and their distinctiveness. American researchers, such as Thurstone, Guilford and their followers, tend to postulate a large number of independent primary abilities, Thurstone identifying no less than seven factors of ability which he labelled 'primary mental abilities'. These were verbal meaning, number facility, inductive reasoning, perceptual speed, spatial relations, memory, and verbal fluency. Guilford has developed an even more elaborate model of the structure of intellect. He proposes a three-dimensional classification of ability factors under the broad categories of contents, products and operations. The model allows for 120 separate abilities each of which should (theoretically at least) be measurable.
General ability theorists, notably of British origin, have also provided us with various hierarchical models of intelligence. Most of these recognise a common underlying component or *g* as being of primary importance and regard the more specialised abilities as subsidiary group factors, useful for prediction in some situations, but not others. Probably the best known of these models is the one constructed by Vernon and reproduced below.

Vernon's theory places a general intellective factor (*g*) at the highest level, followed by two major group factors; verbal-educational (*v:ed*) and practical-mechanical-spatial (*k:m*). Each of these group factors can be further broken down into minor group factors. Specific factors peculiar to certain tests form the last level. The theory synthesizes the work of Spearman and Thurstone but gives central importance to *g*. Put simply, a measure of a person's general ability level (*g*) tells us much about his potential in mainly intellective tasks; his *v:ed* and *k:m* abilities tell us somewhat more about his potential in verbal and practical tasks. Over and above these, the specific abilities may help prediction in particular tasks which require particular skills not accounted for by *g*, *v:ed* and *k:m*.

More recently, Jensen has postulated the existence of two types of abilities: *associative ability* (Level I), and *conceptual ability* (Level II). While these abilities may be positively correlated they also may develop at different rates. Conceptual abilities, as measured by abstract reasoning tasks, are partly dependent on associative abilities, as measured by rote memory, free recall, serial learning and paired-associate learning tasks, but the reverse does not hold. Current tests probably measure both levels, but different tests measure the abilities to different degrees. Jensen believes that although much school learning may be achieved using either conceptual ability or associative ability, schools are geared almost entirely to the use of Level II conceptual abilities. This neglect of associative abilities means that children of poor conceptual ability will fail at school. He also believes that some of these potential school failures may have well-developed associative abilities which could be utilized by teachers in an attempt to prevent academic failure.

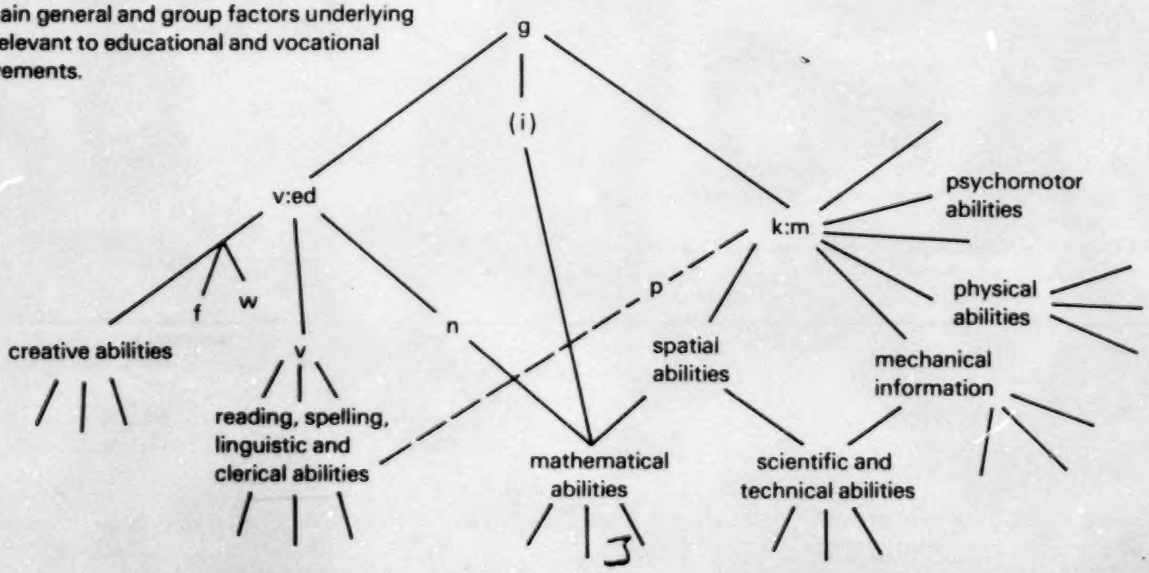
Some theorists think that intelligence is a general attribute, others think that there are many different aspects to intelligence. Because of this lack of agreement there is a wide variety of tests that are subsumed under the mantle of tests of intelligence. However, because of the overlap in abilities, most intelligence tests produce similar results.

What is IQ?

IQ stands for *intelligent quotient* and is one of the most misunderstood concepts in educational measurement, partly because it is not really a quotient at all but a standard score derived from its percentile rank equivalent. In addition there is a widespread erroneous belief that the IQ indicates an innate

The Vernon Model of Intelligence

The main general and group factors underlying tests relevant to educational and vocational achievements.



fixed quality of the individual being tested. Technically, IQs reported for current intelligence tests are really standard scores, designed so that the average individual in each age group receives a score of 100 and the standard deviation for the group is generally 15, that is to say, two thirds of a normal population will fall within 15 points of the average score. So the IQ really indicates a person's level of intellectual ability compared with that of his peers. An IQ of 100 is average; an IQ of 70 indicates a slow learner, in the lowest 2 per cent of the population; an IQ of 130 denotes a very able person, in the highest 2 per cent of the population. Since percentile rank norms do not have the misleading connotation of a fixed, innate quality which has become attached to the IQ some test publishers prefer to report intelligence test results as percentile ranks, rather than as IQs.

To what extent do IQs change over time?

Research findings reviewed by Bloom in his 1964 book, *Stability and Change in Human Characteristics*, show that intelligence test scores are unstable during the early years of life, but by about the age of eight or nine have become relatively constant, that is, they vary by plus or minus six or seven IQ points. However, most of the research studies reviewed by Bloom used individual tests of intelligence. Thus Bloom's generalization, which applied also to group-administered tests, was supported only in part by empirical evidence.

A recent 10 year longitudinal study of the stability of verbal and non-verbal IQs by Hopkins and Bracht shows that below 10 years of age, stability in IQ from group verbal tests is considerably below that for the *Stanford-Binet* (an individual test). Above 10 years, however, they are equally reliable. For two thirds of the population, then, the IQ varies by only 6 points or less, after about 10 years of age. For a very few it may change by 12 or more points. Non-verbal IQs were found to have substantially less stability than verbal IQs over time.

What kinds of intelligence tests are available?

Since psychologists differ in their views about the nature of intelligence, tests which have been designed to measure it vary considerably. Those who accept the importance of *g* have developed tests of general ability which measure a wide variety of skills, for example, the *Otis Tests of Mental Ability*, the *ACER Intermediate D*, the *Stanford-Binet*. Other tests are constructed to measure a student's specific abilities, for example, Thurstone's *Primary Mental Abilities*, the *Differential Aptitude Test*, or the *WISC*. Tests of the latter kind provide a profile of many abilities, and sometimes they also provide a total IQ.

Selecting a test

A teacher's choice of test should be determined by the use to which the results are to be put. Group tests of general ability should be used when information of a general nature, useful for instructional and administration purposes, is required, while the multiple ability tests and specific aptitude tests are most useful in the guidance and counselling of individual pupils, particularly at secondary level and beyond.

Tests of intelligence can also be classified according to the way they are administered. Group tests are designed to be administered to many people at one. They are used more extensively in schools than individually-administered tests because they are less time-consuming and less expensive, yet provide comparable results. On the other hand, individual tests usually provide more information than a global score. Also, although many individual tests are highly verbal in nature they are usually administered orally, and so require considerably less reading ability than most group tests. However, since individual tests of intelligence can only be used by those with specific advanced training they will not be described in any detail in this bulletin.

What is being tested?

Group tests of intelligence are either verbal, for example, the *Otis Tests of Mental Ability*, or non-verbal, for example, the *Jenkins Intermediate Non-Verbal Test*. Some tests include both verbal and non-verbal subtests, for example, the *Cognitive Abilities Test*. A verbal test is one which includes items of a linguistic or quantitative nature and tasks typically included are:

1. verbal analogies; vocabulary —same, opposite; features in common; sentence completion; sentence interpretation; classification; sequence; general information; following directions.
2. quantitative tasks involving numerical series; arithmetical problems; numerical analogies; numerical relationships; quantitative comparisons.

Non-verbal tasks are based on drawings or figures and require classification, selection, and the ability to educe relationships. Cognitive skills of figure classification, figural analogies, and figure synthesis are also included.

Although some of the group tests of intelligence use item content that taps reasoning with pictorial or figural elements, the majority of group tests are verbal in nature and success is dependent, in part at least, upon the examinee's ability to read. If a disability in reading is suspected, then an assessment of general ability can best be obtained by administering either a verbal test orally, for example, the *Tomlinson Junior School Test*, or a non-verbal test, or an individual intelligence test. Since it is obvious that verbal ability is important in school learning, and indeed in most aspects of human achievement, it is not surprising that tests of intelligence used in the school context tend to be highly verbal in nature. And one of the major reasons for using such tests is to predict future academic success.

Are intelligence tests valid?

When using the term validity in relation to tes s and testing we are referring to the degree to which a test is capable of doing the job it was designed to do. Since a single test may be used for many different purposes there is no single validity index for a test. A test that has some validity for one purpose may not be at all valid for another. Therefore, whether a test is valid or not will depend on the use to which the results are to be put, that is, valid for what? Thus, a more vital question is — how valid is the test for the use I have in mind, or to provide the information to assist in the decision I wish to make?

The validity of a test can be established in a number of ways. For example, the *Otis Tests of Mental Ability* are intended to provide an indication of a pupil's acquired facility in a broad variety of reasoning skills, and in manipulating words and numbers in a way similar to that required in the more academic school subjects. Otis' view of intelligence emphasizes the individual's facility in reasoning and dealing abstractly with verbal and symbolic content. The items included in both the Intermediate and Higher forms of these tests are of that type; thus the tests can be said to have some content validity. Statistical evidence is also available which suggests that the *Otis Tests of Mental Ability* provide a valid indication of general scholastic aptitude, predicting success in scholastic examinations. Research by Reid and Hughes, and by Tuck, shows that they also correlate well with other tests of general ability and achievement tests. Thus the *Otis* tests, while not valid measures of Intelligence A, seem to provide valid estimates of Intelligence B, as Otis defines it.

A question frequently asked is, are these tests, in particular

the *Otis*, valid for all children? The point has already been made about the wisdom of using highly verbal tests which require a high level of reading ability with children who cannot read. However, this use would not in fact reduce the test's predictive validity, since it is unlikely that non-readers will succeed academically in school unless their reading handicap can be overcome.

Are they valid for non-European children? Do the tests predict in the same way for non-European children as they do for all pupils? While no substantive New Zealand studies have been carried out, some results reported at the 1975 International Reading Conference by Athol Forsythe suggests that the *Otis* test predicts later achievement for Maoris and Europeans with similar accuracy. Those who question the validity of intelligence tests are possibly questioning the 'fairness' of such tests for minority culture groups.

Are intelligence tests fair?

Most intelligence tests not only require some degree of familiarity with a particular language, but also assume familiarity with a specific culture. Thus the *Otis* tests assume an understanding of our number system, basic vocabulary and an understanding of concepts like 'sentence', 'opposite' and so on. People in different cultures or sub-cultures place different values upon verbal fluency, abstract thought, speed and other aspects that influence the scores on traditional intelligence tests. Some psychologists have attempted to develop tests that are free from cultural influences. Failing in this —for no test can be free from all cultural influences — there have been attempts to develop tests that are equally fair to members of all cultures. In striving to achieve this cultural fairness, tasks involving figural items have been included. However, the research evidence suggests that these tests are not culturally fair if, by this term, we mean groups from one culture score as well as groups from another culture. It is very difficult if not impossible, to construct a test that will show no differences between groups. It is true that by using non-verbal tests we can probe learnings in the non-verbal domain, but this means we have tested only limited aspects of intelligence.

The usefulness of a 'culture fair' test depends on how we wish to use the test scores. By administering a 'culture fair' test, some feel they will get a measure of innate ability or Intelligence A. But we cannot, given the present state of our knowledge, measure innate ability. Others who wish to use intelligence tests primarily as predictive instruments, particularly in the school situation, will be disappointed because 'culture fair' tests have been found to have somewhat less predictive power than verbal tests. This is, of course, understandable given the importance of verbal abilities for success in schools.

As long as our educational system and our general culture emphasize verbal abilities those who aspire to progress in that system and that culture will need to command those abilities.

It is commonly assumed that non-verbal tests are more 'culture fair' than are verbal ones. This assumption no doubt holds true for persons who speak different languages. But for groups speaking a common language whose cultures differ in other important respects, verbal tests may be less culturally loaded than tests of a spatial or perceptual nature.

Since the aspirations of most people are in the direction of success and achievement in the mainstream of society, a strong case can be made for continuing to use tests developed within the dominant culture with minority groups. Whilst acknowledging the fact that such tests will favour those brought up with the language, values, attitudes, and so on, of the dominant culture, scores for minority groups will give an assessment of their present achievement, and provide short term predictions of their ability to succeed within that culture. In the school setting their use will provide an indication of an individual's likelihood of academic achievement and success in the types of work required by an advanced technological society.

What use is made of intelligence test results?

A recent survey (1) of the use made of intelligence tests in primary and intermediate schools shows that New Zealand classroom teachers administer intelligence tests for the following reasons:

1. To provide information about the general mental ability of each pupil (77 per cent of those who had used tests).
2. To identify the most able children (52 per cent).
3. To identify less able children (48 per cent).
4. To provide information that could be used by class teachers in the formulation of instructional programmes (48 per cent).
5. To allow realistic attainment levels to be set for each child (45 per cent).
6. As an aid to class grouping (42 per cent).
7. To identify those children who might benefit most from remedial instruction (42 per cent).
8. As an aid in the classification of new pupils (29 per cent).

The percentages quoted may differ for principals of primary and intermediate schools and for secondary school administrators. However, it is apparent that teachers cite a variety of reasons for using intelligence tests in schools. It is also apparent that teachers find intelligence test results a useful additional piece of information upon which to make more informed decisions about their pupils. It is important to remember that it is not the tests themselves that make the decisions. Test results only provide information which people may use or may not use as they see fit. While intelligence tests have been found to be useful predictors of school learning it is well to remember that they do not predict with absolute precision. Other factors affect a pupil's success at school, for example, his interest and motivation, as well as his general mental ability.

Should results from different intelligence tests be the same?

If the tests used are reliable and comparable (in terms of item type and mode of administration), and are administered under favourable conditions, the results will show remarkable consistency. Of course, there will be occasional variations, but such differences are usually not significant.

When there are significant differences in two test scores an explanation should be sought. Was the pupil ill, were environmental conditions favourable for testing, were errors made in scoring or timing the test, were wrong instructions given by the person administering the test, did the pupil cheat?

Different tests of mental ability may produce different results simply because the items emphasize different kinds of skills. A test which has a higher proportion of numerical items than one which emphasizes reasoning with words will naturally produce a different result for a child with outstanding mathematical abilities. It is therefore prudent to regard an obtained score as only one of many estimates which could be made of a pupil's present level of intellectual ability, that is, as an index of Intelligence C.

Are intelligence tests reliable?

The result of any mental test must be regarded as an estimate of a child's 'true' score. On another day, under different conditions, or with different items, a pupil's score may be expected to be several points higher or lower than the original

score. It is therefore wise to interpret scores using the tolerance of the standard error of measurement for that test, which should be reported in the test manual. In the case of the *Otis Intermediate* the standard error of measurement is between four and five raw score points. That is, the scores of approximately two thirds of the pupils are likely to vary up to plus or minus four raw score points on retesting: the scores of about five per cent of pupils could change by more than eight points. Corresponding allowance should be made for this unreliability when interpreting IQs or percentile rank scores. Thus it is possible for scores to be subject to change and small differences between scores for different pupils, or for the same pupil taking different tests, will be largely attributable to these chance factors.

Are intelligence tests susceptible to coaching?

Coaching for a test of intelligence generally includes the study of tests used previously, practice on reasoning problems used in typical tests and instruction on how to solve problems rapidly. Studies of the effects of coaching have concluded that:

1. Control groups (those which receive no coaching but who merely take the test again) gain on the average two to three IQ points.
2. Coached groups (those having been told about tests and had numerous representative items explained by the teacher) gain about five to six IQ points.
3. Practised but uncoached groups (those who have taken from four to eight tests without special examination) gain about six IQ points.
4. Practised and coached groups may gain 8 to 10 IQ points.

If a person has had no previous experience with objective, speeded tests coaching may increase the score to some extent. However, the advantages arising from coaching are generally small as the gains are rarely sufficient to drastically change the rank order of the pupils. Where pupils have been regularly exposed to objective tests, the advantages of coaching will be even less.

As far as the *Otis Tests of Mental Ability* are concerned research has shown a small practice effect. If an equivalent form of the test is given within a week an average increase of about four or five raw score points has been observed. This effect is reduced with time and would in most cases have disappeared after 2 years. When it is considered that few children would receive the same test within a 2 year period the consequences of the practice effect is somewhat immaterial. The most important point about coaching for a test is that if it occurs there is something wrong with the system. If test results are influencing decision-making to such an extent that coaching in them is seen as being advantageous to some, then testing is becoming an all too important factor in decision-making. Fortunately there is little evidence that this is happening in New Zealand.

When should a non-verbal test be used?

As stated previously, most of the intelligence tests used in the school situation are verbal in nature and assume that those who will be taking the tests have had equal opportunity to acquire the skills which are tested. They also entail a degree of proficiency in the English language. Obviously, these suppositions do not hold true for a number of school children. There are those for whom English is a second language, and there are numbers of both non-European and European children who have different pre-school backgrounds, backgrounds which may not have facilitated the optimum growth of those intellectual skills usually required for school learning.

In view of the language and experiential differences of these children it is frequently thought that the use of a non-verbal test would provide a ready and valid answer to the problem of the assessment of general intelligence.

Such testing cannot, however, make an assessment of the full educational potential of these children. Raven, the author of the *Progressive Matrices Tests*, acknowledged by many as being the tests most 'free' of culture, states that 'by *itself* it [the Progressive Matrices] is not a test of "general intelligence" and it is always a mistake to describe it as such . . it should be used in conjunction with a vocabulary test'.

Further, as stated earlier, there is evidence which demonstrates the fallacy of supposing that non-verbal tests are more free of environmental influences than verbal ones. Whether or not a non-verbal test should be used depends upon the purpose for testing. If one wishes to use a test as a predictor of educational achievement, then verbal tests are superior. But for children with a distinct language deficit, and where there are likely to be difficulties in communicating the verbal content of the test, a non-verbal test would appear to be more appropriate.

It must be remembered that not only is performance on non-verbal tests affected by cultural background but that somewhat different abilities or aspects of intelligence are being assessed. Thus if a non-verbal test is to be used to provide information about the general reasoning ability of certain children the results must be interpreted with care since a test of this type includes items that do not have a close bearing to the kinds of skills involved in school learning. When a pupil scores highly on a non-verbal test, and lowly on both verbal and quantitative batteries, he probably has a good reasoning ability, but is deficient in the types of verbal reasoning most closely related to academic work. If he is identified early enough the deficiency in verbal and quantitative reasoning may be remedied. That is, the results may suggest potential performance on school-related tasks. But can a child use his non-verbal abilities in achieving the school's instructional objectives? Innovative and creative teachers will no doubt try to devise teaching methods which will give these pupils equal opportunities for success, but at the moment there is little evidence to show that such methods are very effective.

Conclusion

The foregoing discussion with respect to the use of intelligence tests means that:

1. Teachers and others can regard intelligence tests as useful measures of general ability in school learning, an ability that is based on prior learning. But they should *not* regard intelligence test scores as an indication of some innate ability. Rather, the tests used in the school situation could more appropriately be termed tests of *scholastic aptitude.*
2. Preference should be given to the use of verbal tests and tests which emphasize abilities developed in school. That is, instead of choosing tests which purport to be 'culturally fair', tests with contents relevant to the learning tasks of the school should be selected.
3. Teachers should not be surprised to get different IQs from different tests, or to find that the same pupil's IQ fluctuates from time to time.
4. Intelligence test scores should be interpreted in the light of other information, for example, cumulative records, teacher observation. That is, an IQ score on its own does not give an accurate and enduring rating of an individual's academic potential.
5. Pupils who are poorly motivated, or who have not had the opportunity to learn the broad, general types of

behaviours sampled by the tests should have these limiting factors taken into consideration by teachers and others when interpreting the test results.

6. Because intelligence tests are measures of general ability they will predict overall school success better than success in a specific subject. They will also correlate more highly with school subjects which require thinking, for example, reading comprehension, rather than with those more readily mastered by rote, for example, spelling. The correlation with subjects dependent on special abilities, for example, music or art, is also likely to be low.

1. The results reported are based on replies from a representative sample of classroom teachers in primary and intermediate schools. Additional information on this survey is available from the Test Development Division, NZCER, P.O. Box 3237, Wellington.

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